This section describes the development and evaluation of land retirement alternatives for drainage management. The land retirement analysis in the 2002 PFR was broadened to respond to requests from stakeholders and interested agencies. Preliminary alternatives were developed, refined, and optimized based on specific criteria. The optimization process led to screening to three alternatives. The evaluation process and results, including descriptions of the three land retirement alternatives, is explained in this section.

3.1 AGENCY AND PUBLIC OUTREACH

Following public review of the PFR, Reclamation and Westlands agreed that the Re-evaluation should consider an alternative(s) that does not directly provide drainage service to some or all lands in the San Luis Unit but provides an alternative to drainage service. With the decision to include land retirement among the alternatives for providing drainage service for the Unit, Reclamation also embarked upon additional public scoping on developing new or modified alternatives and related issues and environmental analysis. Over the period March 1 through March 4, 2004, Reclamation conducted scoping meetings (including meetings with stakeholders) at four locations: Sacramento, Concord, Fresno, and Cayucos. At these meetings, Reclamation outlined its approach to the analysis, including factors influencing land retirement, and requested comments on components of a land retirement alternative and environmental issues and impacts associated with land retirement that should be covered in the EIS. The issues that were raised on how land retirement would be defined or implemented along with responses from Reclamation are summarized in a separate Scoping Report.

3.2 PRELIMINARY LAND RETIREMENT ALTERNATIVES

This section outlines the development of preliminary land retirement alternatives, while subsequent sections focus on the refinement and optimization of alternatives.

3.2.1 Study Parameters

The process of developing land retirement alternatives began in October 2003 with a meeting with project stakeholders to develop study parameters for incorporating land retirement into the disposal alternatives. Representatives from San Luis Unit districts (San Luis Water District, Broadview Water District, Westlands Water District, and Panoche Water and Drainage District) and San Joaquin River Exchange Contractors Water Authority met with Management and Technical Team members to determine critical steps and elements for development of land retirement alternatives. The resulting steps and elements are:

- Provide a structure and framework to develop a complete locally preferred alternative and other complete drainage service alternatives with land retirement
- Refine the definitions from the Westside Regional Drainage Plan (San Joaquin River Exchange Contractors Water Authority et al. 2003) including lands within Westlands and the Northerly Area
- Define the parameters that characterize the land retirement component in Westlands and Northerly drainage-impaired areas, specifically:
  - Lands to be retired

    - Optimize land retirement
    - Retire all drainage-impaired lands in the San Luis Unit
  - Implementation method
    - Voluntary acquisitions
    - Identify specific lands for retirement
  - Future land use
    - Private vs. public ownership and uses
  - Future water use
    - Water remains in the San Luis Unit
    - Water remains in the CVP
    - Water is used for other purposes

The structure and framework uses the In-Valley Disposal Alternative from the PFR combined with recommendations from stakeholders and comments on the PFR. The definitions and parameters that characterized development of the initial land retirement component are as follows:

- **Lands to be Retired** –The amount of acres to retire in the alternatives ranged from all drainage-impaired lands in the Unit (343,000 acres) to the lands identified in the No Action Alternative (109,100 acres). Of these 109,100 acres, 65,000 acres from the Westlands Settlement Agreement could go back into production with the provision of drainage service. It was necessary to optimize which lands should be retired based on some criteria (cost/benefit analysis, shallow groundwater or salt in the root zone) and relevance to the purpose and need statement of the Re-evaluation. The amount of lands that Westlands has proposed to be retired and those identified under the optimization process may not be the same.
- **Implementation Method** – Careful implementation of any selected land retirement scenario is needed, because random acquisition of drainage-impaired lands could impact the effectiveness of proposed drainage service systems and potentially be difficult to manage and implement. Voluntary cooperation with the retirement program would provide flexibility for area farmers, but could result in a checkerboard pattern of acquired lands that would be inefficient for implementation of drainage service for nonretired lands. Identifying a target area within which acquisition would occur might benefit the effectiveness of subsequent drainage service efforts, but could mean that the retirement would be mandatory. A system that targets certain areas, rather than providing a purely voluntary system, including a "stepped approach (whole areas approached for voluntary retirement)" of land acquisition might be successful.
- **Future Land Use** – All alternatives formulated need to be complete and, therefore, would have to include a description of the ultimate use of retired lands. Local and regional restrictions (local general plans and zoning) would occur that may constrain potential uses. Potential uses for retired lands include:
  - Restoration to native habitat

- Habitat improvements (provide wildlife corridors, linkages, seasonal habitat)
- Conversion to nonirrigated agriculture

The alternative would have to consider the potential impacts to adjacent lands including issues of flood and weed control. Reclamation would want to identify what restrictions would need to be placed on lands that were not ultimately owned by the Federal government. Reclamation would likely define parameters of what will not happen (e.g., irrigated agriculture).

- **Water Use** – Regarding the potential disposition of the water no longer required for use on retired lands, the following potential uses were identified:
  - Water remains in the San Luis Unit
    - No modifications to existing contracts
    - Allocation among users remains unchanged
  - Water remains in the CVP
    - Contracts modified based on water needs assessment
    - Allocation among users could change
  - Water used for other purposes
    - Unlikely since water cannot leave the CVP

3.2.2 Preliminary Alternatives

Subsequent meetings resulted in evaluation of seven initial alternatives: two locally preferred (including the Westside Regional Drainage Plan), two identified by Reclamation, one representing U.S. Fish and Wildlife Service comments on the PFR, the "Drainage Without a Drain" concept proposed by a coalition of environmental groups and local agencies downstream of the San Joaquin Valley, and a maximum retire all drainage-impaired lands in the Unit. The Project Team refined alternatives developed from the public outreach process to develop complete alternatives. Factors considered included:

- Amount of land retirement
- Land retirement implementation method
- Future retired land use and ownership
- Use of water associated with retired land
- Extent of drainage reduction measures including irrigation efficiencies and groundwater pumping
- Inclusion of drainage service components necessary to provide a complete disposal alternative

By December 2003, the following five concepts were identified for further refinement and optimization:

- Locally Preferred 1: Westside Regional Drainage Plan

- Locally Preferred 2: Optimized Retirement
- Reclamation 1: Federal Management
- Reclamation 2: Maximum Retirement
- Environmental: Drainage Without a Drain

The characteristics of these alternatives are shown on Table 3-1, along with the In-Valley Disposal Alternative without the additional land retirement component, for comparison purposes.

Table 3-1
Additional Alternatives Development – December 2003

	LP_1 Westside Regional Drainage Plan (WRDP)	LP_2 Optimized Retirement	R_1 Federal Management	R_2 Maximum Retirement	E_1 Drainage without a Drain	In-Valley Disposal Alternative[1]
Interest/Proponent	Local Water Districts	Local Water Districts	Reclamation/NEPA	Reclamation/NEPA	Environmental Interests	Reclamation/NEPA
Westlands Lands Retired	150,000–200,000 acres Specified by Westlands	Optimized[2]	Optimized	All drainage-impaired lands	200,000 acres or more, to include severely drainage-, Se-, and/or salt-impaired lands	CVPIA Land Retirement & Settlement Lands 44,106 acres total
Northerly Area Lands Retired	Only lands necessary for facilities	Optimized	Optimized	All drainage-impaired lands	Severely drainage-, Se-, and/or salt-impaired lands	Only lands necessary for facilities
Retired Lands Implementation Method	Voluntary[9]	Mandatory	Mandatory or Voluntary determined in optimization	Mandatory	Voluntary	Voluntary (CVPIA) Mandatory (Settlements)
Source Control	In-Valley Plan[3] plus groundwater pumping in Northerly Area	In-Valley Plan plus groundwater pumping in Northerly Area	In-Valley Plan	N/A	In-Valley Plan[4] plus improvements in nonfarm irrigation efficiency (to achieve seepage no greater than 0.3 AF/acre), fallowing, reuse/drainwater management (including use of drainwater to irrigate marketable crops, use of drainwater for dust control, etc.), and on-farm sequential reuse[5]	In-Valley Plan
Future Retired Land Ownership	Water Districts	Water Districts	Federal	Federal	Initially Federal, although lands could be resold with appropriate deed restrictions	Federal (CVPIA) Districts (Settlements)
Future Retired Land Use	Westlands Land Use Plan[6]	Westlands Land Use Plan	Native upland habitat No irrigation	Native upland habitat No irrigation	Native upland habitat, dryland farming, drainage treatment	Native upland habitat (CVPIA) District management – no irrigation (Settlement)
Retired Land Water Use	No change in water contracts	No change in water contracts	CVP retains water	CVP retains water	Water reverts to CVP for use in meeting environmental[7] and other commitments	No change in water contracts
Other Westlands Components	No collector system Reuse, menu of treatment technologies Disposal: Deferred	In-Valley[8] alternative facilities scaled to meet need	In-Valley alternative facilities scaled to meet need	N/A	Similar to WRDP Salt harvesting Disposal: Deferred	In-Valley Alternative facilities
Other Northerly Area Components	Disposal: Deferred	In-Valley alternative facilities scaled to meet need	In-Valley alternative facilities scaled to meet need	N/A	Disposal: Deferred	In-Valley Alternative facilities

1. Components of the In-Valley Alternative as of July 2003 *Administrative Draft EIS.*
2. Optimization analysis will consider various amounts of land retirement in combination with drainage facilities to determine the optimum amount of land to retire. Optimization criteria will include total cost and remaining agricultural productivity.
3. Shallow groundwater management, seepage reduction, drainage recycling – estimated reduction of 28,200 AF/yr.
4. The In-Valley Plan assumes that drainwater recycling, shallow groundwater management, and seepage reduction (as described on page 5-5 of the 2002 PFR) will occur prior to drainage service.
5. Note that these actions were eliminated as not cost-effective in the PFR. It is strongly recommend that they be included in all alternatives.
6. Detailed land use plan includes the following uses: Highway 180 Business Corridor (commercial and/or industrial), flood control facilities, wildlife corridor, dry land farming, hunting, drainage treatment and reuse.
7. Environmental commitments would include currently unmet flow objectives in streams controlled by the Central Valley Project (including the Trinity), export reduction objectives in the Bay-Delta, and other environmental objectives that are not met due to current Interior operating policies and/or help in meeting mandates for Endangered Species Act, CVPIA, Clean Water Act, and other federal laws.
8. In-Valley alternative facilities: collector system, regional reuse areas, biological Se treatment, RO in Northerly Area, evaporation ponds.
9. In this case, specific drainage-impaired lands would not be provided drainage service but alternatively offered a land retirement buy out.

3.3 LAND RETIREMENT REFINEMENT AND OPTIMIZATION

Land retirement alternatives were evaluated to determine how the cost, benefit, and potential environmental impacts of the resulting drainage service plan compared to previous alternatives using a variety of modeling and analysis tools. Initially, the amount of drainage to be expected under the different land retirement scenarios was determined using the regional groundwater model. These results were then used to estimate the cost of drainage service for the land retirement scenarios using engineering cost curves, which calculated the cost for each component of drainage service (e.g., collector system, selenium [Se] treatment system) for a corresponding drainage flow rate. Next, the National Economic Development (NED) benefit of each scenario was calculated to provide another measure to select a final set of scenarios for analysis. Finally, indicators of environmental impact (such as acres of reuse and evaporation ponds needed, or amount of drainwater reclaimed for irrigation) were developed for each scenario. The results were used to select a short list of land retirement alternatives for further evaluation prior to incorporation into the EIS.

Alternatives that provided for partial retirement of drainage-impaired lands were further evaluated to balance the amount of land retired with the implementation of drainage-reduction measures to improve farm profits. The primary drainage-reduction measure evaluated was increases in irrigation efficiencies (i.e., reductions in percolation losses).

Because the cost of Se removal from drainwater is high, Reclamation developed a land retirement alternative that was based on retiring lands with high Se concentrations in the shallow groundwater. The Project Team used groundwater well monitoring data to develop estimates of the Se concentration in shallow groundwater. Several different groundwater concentrations were used as criteria for selecting land retirement areas. The alternatives were assessed based on the amount of land that would be retired and the potential decrease in Se concentration in drainwater. In addition, the effect of retiring lands already acquired by Westlands on drainwater quality was evaluated.

3.3.1 Approach

The primary objective of any land retirement alternative is to reduce the amount of subsurface drainwater needing treatment and disposal. Several key considerations are:

- Drainage treatment and disposal is costly. Reducing the amount of drainwater can allow for smaller sizing of facilities, thereby reducing costs.
- Even with appropriate mitigation, treatment and disposal present some level of environmental risk. In past drainage management studies, political opposition to large-scale treatment and disposal facilities has been strong.
- Changes in CVP water deliveries have resulted from implementation of the CVPIA, Endangered Species Act Biological Opinions affecting Delta pumping, and other water quality restrictions. Planned land retirement not only reduces the need for drainage facilities, but also reduces the need either to develop more costly replacement water supply or to fallow land involuntarily due to water shortages in the Unit.

Reclamation developed and analyzed potential alternatives that would include combinations of land retirement, drainwater/source reduction (including reduced percolation losses from irrigation, and drainwater recycling and reuse), and treatment and disposal. These potential alternatives, called land retirement scenarios, would be compared primarily using costs. Scenarios would mix different levels of land retirement, source reduction, and treatment/disposal. Costs considered were:

- Costs of purchasing land for retirement, including:
  - Payments to growers to compensate them for the lost value of land
  - Costs to manage the retired land
- Costs of irrigation and management changes to improve efficiency and reduce percolation losses
- Costs of other source reduction, including shallow groundwater management, drainwater recycling, and reuse
- Costs of treatment and disposal of remaining drainwater

In addition to costs, other analyses provided information on groundwater impacts, root zone salt balance, and change in applied water.

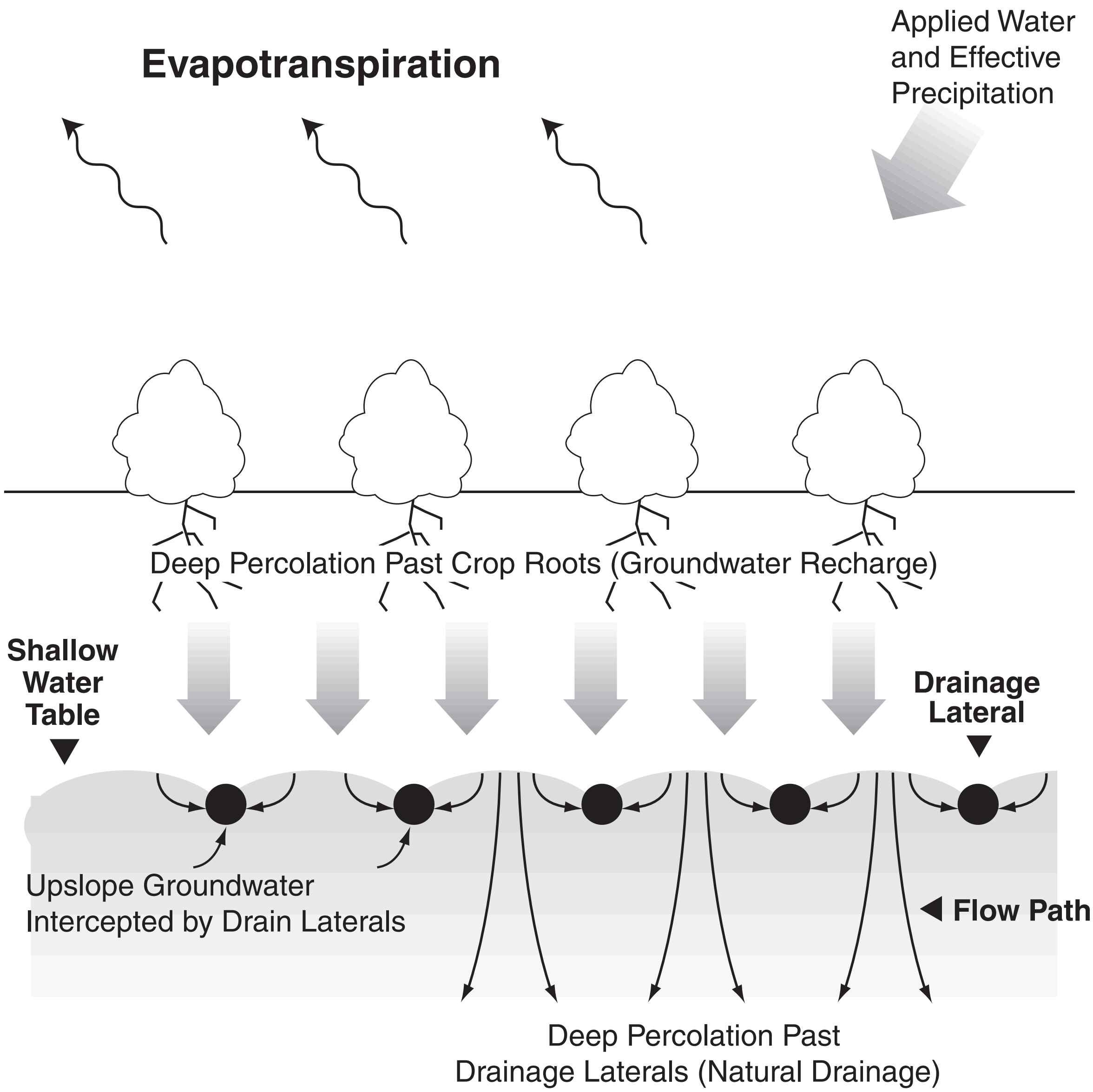
3.3.2 Groundwater Impacts

The effects of both land retirement and reductions in deep percolation to shallow groundwater (i.e., increased irrigation efficiency) on regional groundwater levels are important for assessing overall costs and benefits of land retirement scenarios. Both land retirement and deep percolation reduction have long-term effects on the balance of flows into and out of the groundwater, which in turn affect the trend in shallow groundwater levels over time. Figure 3-1 illustrates the potential fates for deep percolation and other contributing water sources to drainflow. In the screening analysis for land retirement optimization, a groundwater model was used to estimate the acreage of lands needing drainage, the drainage rate per acre, and the total drainflow. Appendix A describes the groundwater modeling analysis.

3.3.3 Land Retirement Costs

Based on recent data on land sales and purchases of land for other recent retirement or fallowing programs, payment to growers is estimated to be $2,600 per acre. This is a one-time payment or the present value equivalent if payments are made in more than one installment. This value is estimated from observed transactions, but it can be viewed as the value that willing sellers believe compensates them for the lost stream of expected net returns from farming.

Land management costs are estimated based on the assumed use of the land after purchase. For purposes of the screening analysis, land is assumed to be managed in a mix of ways. One-third of the purchased land would be used for dry land farming, one-third would be used for grazing, and one-third would remain fallow. Dry land farming and grazing would require some initial capital investment, and all three would require annual maintenance. Table 3-2 shows the capital and operation and maintenance (O&M) costs for the three land management options.



Potential Fates for Deep Percolation and Contributing Water Sources to Drainflow

Figure 3-1

Table 3-2
Unit Cost Estimates for Land Management Options

Dry Land Farming ($/acre)	Grazing ($/acre)	Fallowing ($/acre)	Average Cost ($/acre)
Capital Costs			
$35	$47	$0	$27.33
OM&R Costs			
$15	$–*	$30	$15.00

*No net annual O&M costs because grazing for revenue offsets costs.

Both the initial purchase and the ongoing maintenance program would require administration. This assessment assumes a 15 percent overhead cost on both the capital and O&M costs.

Restoration costs of the retired lands were also considered. Restoring native plants on the retired lands can be $1,000 to $2,000 per acre, with seed acquisition being the largest cost variable. A native plant nursery can be established to provide seed for surrounding areas, depending on the goals of the program. Because the restoration costs for the retired lands are high and would not directly meet the Re-evaluation’s purpose and need, environmental restoration costs were not considered part of land retirement costs. Reclamation’s Interagency Land Retirement Team is studying restoration of retired lands under the CVPIA Land Retirement Program.

3.3.4 Deep Percolation Reduction Costs

Costs of reducing deep percolation losses from irrigation were estimated using an irrigation cost and performance model developed for the California Bay-Delta Authority’s Water Use Efficiency Program (CBDA 2004). The model is built on a database of irrigation technologies that are both feasible and cost-effective. The database was created in an earlier study (CH2M Hill 1990), and was updated for use in assessing CVPIA’s agricultural impacts (CH2M Hill 1994). These studies estimated irrigation costs and performance characteristics (including application efficiency) for 8 crop categories, 15 irrigation systems, 3 management levels, and 3 regions within the Central Valley. Data for San Joaquin Valley costs and performance were used for the current study. Not all combinations of these parameters were investigated–some combinations such as drip irrigation on grain or linear-move sprinklers on orchards simply are not feasible or cost-effective and were excluded.

The data included estimates of capital component costs (pipes, valves, siphon tubes, land leveling, etc.), operational costs (labor, repairs, pressurization pumping), and management costs. For consistent comparison across systems, all costs were converted to annualized equivalents, with each capital component amortized over its useful life. Total annual costs for each system included annualized capital plus O&M costs.

In addition to costs, each feasible irrigation system was characterized according to its seasonal water use efficiency. For each system and crop, the total applied water was broken into four fractions or percentages:

- Consumptive use fraction – the percent that contributes to crop evapotranspiration (often referred to as evapotranspiration of applied water)
- Deep percolation fraction – the percent of applied water that percolates below the crop root zone
- Uncollected runoff fraction – surface return (often called tailwater) of applied water that is not collected and reused by a field-level reuse system
- Evaporation fraction – the percent of applied water that evaporates during the irrigation application

For purposes of this addendum and this analysis, seasonal application efficiency is defined as the ratio of the consumptive use of applied irrigation water (evapotranspiration of applied water) to the total applied water. Other studies may define application efficiency in a different way. For example, some reports add additional water applied for leaching and other cultivation practices to the consumptive use before dividing the result by total applied water. Efficiencies calculated in that way are not directly comparable to the efficiency estimates used here.

Irrigation system changes can reduce subsurface drainage by reducing the amount of deep percolation reaching the shallow groundwater. For this analysis, current regional average deep percolation rates (in acre feet [AF]/irrigated acre/year or, equivalently, in feet/year) are estimated for each crop category in the drainage-impaired area. This calibration to current conditions relies on the best available data on the mix of irrigation systems currently in use for the region and on the seasonal application efficiency by crop. The result of the calibration step is a mix of irrigation systems for each crop in the study area, the efficiency and deep percolation associated with the crop, and the annual cost per acre for that mix of irrigation systems. No modeling analysis can replicate the actual conditions on every irrigated acre in the study area, but the calibration results represent a reasonable estimate of the mix of systems, crops, and overall efficiencies.

After calibration, an optimization model is used to estimate the least-cost change in the mix of irrigation systems needed to achieve target reductions in regional deep percolation rates. This analysis was performed for three different starting conditions, corresponding to three distinct analysis regions within the San Luis Unit: the drainage-impaired area within Westlands, upslope land within Westlands, and lands in the Northerly Area districts of San Luis Unit. These three areas have different crop mixes and their current deep percolation rates and seasonal application efficiencies are different. The Westlands drainage-impaired area has a low rate of natural drainage and no artificial drainage, requiring crop mix and irrigation practices that result in lower deep percolation rates than the other two areas. Therefore, the amount of potential reduction in deep percolation is lower in that area, and the costs of that reduction would be higher.

Two scenarios of deep percolation reductions were assessed. The first, denoted as Level 1, reduced average deep percolation by 0.05 foot/year in the Westlands drainage-impaired area, and by 0.1 foot/year in other areas. The Level 2 scenario reduced deep percolation by 0.07 foot/acre in the Westlands drainage-impaired area, and by 0.15 foot/year in the other two areas. Table 3-3 shows the assumptions used for estimating the costs of deep percolation reductions.

Table 3-3
Assumptions Used to Assess Costs of Deep Percolation Reduction

Areas for Application Efficiency Analysis	Estimated Current Condition Deep Percolation Rate*	Current Condition Deep Percolation Rate Assumed for Cost Analysis	Level 1 Potential Reduction in Deep Percolation	Level 2 Potential Reduction in Deep Percolation
Westlands Drainage-Impaired Area	0.32 foot/year	0.32 foot/year	Reduce by 0.05 foot/year	Reduce by 0.07 foot/year
Westlands Upslope Area	0.5 – 0.65 foot/year	0.5 foot/year	Reduce by 0.10 foot/year	Reduce by 0.15 foot/year
Northerly Area	0.5 – 0.7 foot/year	0.5 foot/year	Reduce by 0.10 foot/year	Reduce by 0.15 foot/year

*Based on estimates from groundwater analysis. See Appendix A.

The cost analysis assumed that current conditions start at the lower end of the deep percolation estimates provided by the groundwater modeling. This conservative approach was used to reduce the chance of underestimating costs. The magnitude of reductions was lower in the drainage-impaired area simply because that area starts at a much lower level, corresponding to higher application efficiencies on irrigated land. As a result, the area has less leeway to reduce deep percolation further and still achieve adequate leaching.

3.3.5 Other Drainwater Reduction Costs

Three other drainwater reduction (source control) measures are included in all of the land retirement scenarios: shallow groundwater management, canal seepage reduction, and regional drainwater recycling.[1] Section 4.2.3 presents the criteria used to select the drainwater reduction measures for the land retirement optimization. In practice, other drainwater reduction measures could be implemented by districts, if an equivalent level of reduction was provided.

Previous studies have demonstrated the potential for reducing drainflow on drained lands by managing the water table over the growing season. **Shallow groundwater management** uses valves on subsurface drains to control the water table and allow the crop to use a portion of that water to meet part of its evapotranspiration need. No additional capital costs are anticipated for shallow groundwater management since water table control structures (DOS valves) are needed for early season drainwater release control to the reuse areas. Costs for DOS valves are already included in on-farm drainage system costs. Additional annual O&M costs are estimated to be $18.80/acre/year.

A second drainwater reduction measure would **reduce seepage of water from delivery canals** in the Northerly Area. This seepage currently adds to the shallow groundwater and increases the total amount of shallow groundwater needing to be drained, treated, and disposed. Costs to construct the canal seepage reduction are estimated to be $8 million. Savings in water delivery

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[1] All of these measures are described in the PFR (Section 3.2, Reclamation 2002) and in the Source Control Technical Memorandum (URS 2002). These documents describe the analysis used to develop the drainwater reduction measures.

costs and canal maintenance would more than offset the operation, maintenance, and replacement (OM&R) costs for the seepage reduction, resulting in a net OM&R savings of about $18,600/year.

A third drainwater reduction measure is **regional drainwater recycling**, which consists of collecting a portion of the subsurface drainwater, mixing it with existing freshwater supply, and redistributing it for use by irrigators. Such a system is already in use in the Northerly Area districts, so no major construction is needed. Unit cost in the Northerly Area is estimated to be $4.40/acre receiving the recycled drainwater. In Westlands, no such system exists currently. As part of plan formulation, a system was developed that would recycle and blend drainwater with fresh irrigation water to a maximum total dissolved solids (TDS) of 600 parts per million. Construction cost is estimated to be $167/acre receiving recycled water, with OM&R costs ranging from $2.00 to 2.40/acre, depending on the location within Westlands.

3.3.6 Collection, Treatment, and Disposal Costs

Collection costs include on-farm drain installation and operation, and a regional collection system to carry the drainwater away from irrigated lands to the reuse areas. Costs for these are shown in Table 3-4.

Table 3-4
Summary of Unit Cost Estimates for On-Farm Drains, Collection, and Reuse

Facility	Capital Cost	Annual OM&R Cost
On-Farm Drains	$665/acre drained	$9.40/acre drained
Collection System	Westlands: $750/acre in collection area Northerly Area: $375/acre in collection area	All areas: $12/acre in collection area
Reuse Areas	$4,450/acre of reuse area	$200/acre of reuse area

After drainwater is applied to reuse areas, remaining drainage is conveyed to the final treatment and disposal processes, consisting of reverse osmosis (RO) of the drainwater from the reuse areas, Se treatment, and disposal to evaporation ponds. Costs of these processes, including conveyance among them, were based on preliminary estimates of several different scales of facilities. Cost estimate functions were fit to these data, to allow interpolation of costs for different scales as needed by the land retirement screening analysis. The cost estimate methodology is summarized in Appendix B.

3.3.7 Value of Agricultural Production Lost to Retirement

Payments for purchasing and retiring land represent a transfer of income from the buyer (the Federal government, initially) to the landowners. As costs of the program are repaid over time, money is transferred back from the land retirement area to the Federal treasury. From the perspective of the national economy, these movements of money, though very important to those involved, are simply transfer payments among groups of citizens. The real change to the economy is the loss of current and future agricultural net income from the retired lands.

The *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (U.S. Water Resources Council 1983; subsequently referenced simply as *Principles and Guidelines*) provides guidance for estimating the economic loss from retiring agricultural lands. In essence, the *Principles and Guidelines* recommend using market valuation of goods and services as the best estimate of economic value, except where a substantial distortion may occur due to market failure or government involvement (such as regulatory restrictions or subsidy programs). Crop production is a case where adjustments are made to account for the effects of subsidy payments under Federal farm commodity programs. Net income from agricultural production was estimated using information on crop prices, crop yields, costs of production, and crop mix.

Most of the data for the analysis were compiled during preparation of the original 2002 PFR and the unpublished Administrative Draft EIS (Reclamation 2003a). Data for cotton production were updated to 2003 levels because of cotton's unique importance in the study area – it by far covers the largest acreage and provides the largest total revenue of any crop in the drainage-impaired area of the San Luis Unit.

3.3.7.1 Crop Mix

The analysis grouped crops of the San Luis Unit into nine categories:

- **Forage Crops.** Alfalfa hay is the largest crop in this category and its cost and revenue is used to represent the category.
- **Cotton.** A weighted average of prices and yields for two varieties is used. Upland cotton has historically been the dominant variety, but Pima cotton has increased in importance in recent years. Crop acreage data from Westlands shows that, for the years 1999–2002, Upland cotton was grown on about two-thirds of the cotton acreage and Pima was grown on the remainder.
- **Other Field Crops.** These include alfalfa seed, field corn, dry beans, oil seed crops, and others. Alfalfa seed is used to represent this category.
- **Small Grains.** Wheat and barley are the dominant crops. Wheat is used to represent this category.
- **Grapes.** Production costs and revenues for wine grapes are used for this category.
- **Sugar Beets.** No crops other than sugar beets are in this category.
- **Orchards.** Important crops include almonds, pistachios, and stone fruits. Almonds are used as the representative crop.
- **Tomatoes.** Both processing and fresh-market tomatoes are grown. Processing tomato costs and returns are used to represent this category.
- **Truck Crops.** Crops with the largest acreage include melons, lettuce, sweet corn, onion, and garlic. Cantaloupes are used to represent this category.

The *Principles and Guidelines* divide crops into two classes. Basic crops are those for which a change in acreage will have little or no effect on price. Acreages of basic crops are generally limited by available resources (land or water), and include cotton, small grains, corn, hay, and pasture. Other crops are limited by market demand, either through explicit marketing or processing contracts (like processing tomatoes) or through the price effects that changes in production would cause. The *Principles and Guidelines* argue that changes in acreage in a region will, under most conditions, occur in the basic crops, and prescribe that changes in crop acreage be valued using only those crops.

This analysis assumes that the following crop categories would shift to other lands within the San Luis Unit or elsewhere in the San Joaquin Valley if they are currently grown on lands that are retired: grapes, orchards, tomatoes, and truck crops. The remaining crop categories that would be affected are forage crops, cotton, other field crops, small grains, and sugar beets.

3.3.7.2 Crop Yields

Crop yields were estimated from Fresno County Agricultural Commissioner annual reports, using the average for the latest 5 years available (Fresno County Agricultural Commissioner 1997–2001).

3.3.7.3 Crop Prices

For crops unaffected by Federal farm commodity programs, prices are also County averages over 5 years (Fresno County Agricultural Commissioner 1997-2001). The U.S. Department of Agriculture (various years) estimates “normalized” prices for crops affected by commodity programs. These include alfalfa hay, upland cotton, small grains, and sugar beets. The normalized prices are statistical estimates of the market prices in the absence of commodity programs and other market-distorting influences.

3.3.7.4 Production Costs

University of California Cooperative Extension prepares sample costs to produce many different crops grown in the San Joaquin Valley. These sample costs are used to create crop production budgets for the representative crops in each of the crop categories.

Table 3-5 summarizes the values for yields, prices, and production costs used in the analysis. Not all of these crops are grown in every area within the San Luis Unit.

Table 3-5
Summary of Crop Revenue and Cost Estimates Used in Land Retirement Optimization

Crop	Units	Yield (units per acre)	Price ($ per unit)	Gross Revenue ($ per acre)	Production Costs ($ per acre)	Net Revenue ($ per acre)[2]
Alfalfa Hay	tons	7.60	99.55	756.18	578.82	177.36
Cotton[1]	pounds	1,319.00	0.76	992.95	814.68	178.27
Field	pounds	614.00	1.56	957.84	455.61	502.23
Grain	tons	2.73	104.00	283.92	428.18	-144.27
Grapes	tons	10.12	366.20	3706.68	1625.59	2081.08
Sugarbeets	tons	33.73	35.09	1183.45	466.81	716.64
Orchard	tons	0.98	2,608.00	2566.27	1696.52	869.75
Tomato	tons	38.27	52.00	1990.04	1228.91	761.13
Truck	tons	12.95	211.40	2737.21	2291.43	445.78

[1]Cotton is a weighted average of Upland cotton and Pima cotton.
[2]Returns to land, water, management, and risk.

3.3.8 Avoided Cost of Additional Water Supply

The San Luis Unit does not receive its full contract quantity of CVP water in the majority of years. Changes in CVP water deliveries have resulted from implementation of the CVPIA, Endangered Species Act Biological Opinions affecting Delta pumping, and other water quality restrictions. This analysis assumes that the Unit will receive, on average, 70 percent of its CVP delivery.

Planned land retirement in Westlands not only reduces the need for drainage facilities, but also reduces the need either to develop more costly replacement water supply or to fallow land involuntarily due to water shortage. Assuming that, in the absence of land retirement, Westlands would purchase or develop supply to meet its full water demand, one of the benefits of retirement would be to avoid that cost. Several sources of information were used to estimate what Westlands would have to pay to purchase or develop replacement supply:

- Groundwater storage conjunctive use projects submitted for state funding in the last two years included several in the western and southern San Joaquin Valley. Annualized costs per AF of yield for these projects ranged from about $70/AF to over $200/AF (DWR 2003).
- The Environmental Water Account (a program of the California Bay-Delta Authority) estimates that it will pay $140/AF, on average, for water it provides south of the Delta.
- The California Bay-Delta Authority has developed estimates of the willingness to pay for new water supply by different user groups. Its estimate for CVP Delta export agricultural users ranges from $80 to $125/AF, depending on year type, with an average of $90/AF.

These cited values represent the cost to acquire and deliver water to a district in the San Luis Unit such as Westlands. District costs to cover its internal expenses to deliver the water to its growers are not included. For purposes of screening land retirement scenarios, a cost of $90/AF is assumed to acquire or develop replacement water for the San Luis Unit (again, district delivery charges are not included).

3.3.9 Other Analyses

3.3.9.1 Root Zone Salinity Assessment

Deep percolation reductions, especially in the drainage-impaired area, reduce the amount of water available to leach salts out of the root zone. A root zone salt balance model is used as a screening tool to assess whether salt balance can be achieved. The model considers the crop mix and water application rates, salinity of applied water, depth and salinity of shallow groundwater, and total available drainage (both natural and artificial). Root zone and shallow groundwater salinity are simulated over a 50-year period to assess whether salt concentrations show trends or achieve levels acceptable for the typical mix of crops. Results of this analysis are not expressed as a dollar cost or benefit. Rather, for the land retirement optimization analysis the salinity assessment is used as a check of whether a particular retirement and source control scenario is technically practical and meets the Re-evaluation's purpose and need.

3.3.9.2 Water Made Available for Other Uses

Land retirement and irrigation system improvements to reduce deep percolation losses both reduce the total amount of irrigation water demanded in the San Luis Unit. As described earlier, the Unit currently can expect to receive only about 70 percent of its CVP contract supply on average. The amount of water made available from land retirement is calculated based on the net change in crop acreage resulting from the retirement program. Water made available from irrigation improvements is estimated using the irrigation cost and performance model described above for deep percolation reduction costs.

3.3.10 Alternative Analysis Results

A two-step process was used to evaluate, compare, and screen land retirement scenarios down to a final set of three. The first step covered a fairly wide range of retirement and source control combinations, and was used to:

- Screen out scenarios that were clearly inferior (e.g., more costly for the same or less benefit).
- Screen out scenarios that were technically impractical or questionable.
- Identify potential scenarios that might be more effective and/or less costly.

The second step evaluated four scenarios in comparison to the In-Valley Disposal Alternative, including the change in applied water.

3.3.10.1 Initial Screening

Three land retirement levels and three deep percolation levels (e.g., irrigation efficiency levels were evaluated. The three retirement levels were:

- Lands retired as in the In-Valley Disposal Alternative (approximately 44,100 acres within Westlands drainage-impaired area)
- 200,000 acres retired within the Westlands drainage-impaired area
- All drainage-impaired lands retired in the Unit (298,000 acres in Westlands and 45,000 acres in the Northerly Area)

Three increased irrigation efficiency (deep percolation, or shallow groundwater recharge) rates were evaluated for the first two retirement levels (because with all drainage-impaired lands retired, reducing drainage with source control is not needed). These levels were described above.

The following conclusions were drawn from the initial screening:

- Comparison of the Federal cost for land retirement (land acquisition cost, management cost) versus the Federal cost for collection, treatment, and disposal indicated that land retirement was more costly. In other words, it cost more to avoid the drainage through land retirement than to collect, treat, and dispose of the drainwater.
- Further analysis is needed to estimate the value of water that land retirement makes available for other uses and should be factored into the comparison of final alternatives. The *Principles and Guidelines* (referenced above) should also be used to compare scenarios.
- Root zone salinity analysis indicated that Level 2 deep percolation reduction (i.e., increased irrigation efficiency) probably does not allow for salinity balance in the root zone for the drainage-impaired area. Level 2 deep percolation reduction was eliminated from further consideration.
- Level 1 deep percolation reduction did appear to be technically feasible and cost-effective, but root zone salinity balance in the Westlands drainage-impaired area could be achieved only with extremely careful management. It was agreed to include Level 1 reduction in further screening of scenarios, although questions were raised about the practicality of growers being able to achieve deep percolation rates of 0.27 foot/year.
- Full retirement of drainage-impaired lands in Westlands eliminated the need for drainage, but the 200,000-acre retirement level did not. Analysis of additional intermediate levels of retirement was suggested to see if some acreage less than full retirement could eliminate the need for drainage service in Westlands.
- Other implications besides cost and drainage volume were suggested for consideration in the land retirement scenario screening. Specifically, a scenario could target retirement of lands based on Se concentrations in shallow groundwater. Two target levels were suggested: greater than 20 parts per billion (ppb) and greater than 50 ppb Se in shallow groundwater.

3.3.10.2 Second Screening

Four scenarios were evaluated and compared in this screening:

- Revision of the In-Valley Disposal Alternative to include Level 1 deep percolation reduction and 55,311 total acres retired in Westlands (including lands for project facilities).

- Retirement of all lands in Westlands with Se concentration greater than 50 ppb and implementing Level 1 deep percolation reduction. Total land retired would be 88,576 acres in Westlands and the 10,000 acres of Broadview Water District in the Northerly Area.
- Retirement of all lands in Westlands with Se concentration greater than 20 ppb and implementing Level 1 deep percolation reduction. Total land retired would be 129,051 acres in Westlands and the 10,000 acres of Broadview Water District in the Northerly Area.
- Retirement of 198,000 acres within the drainage-impaired area of Westlands plus 10,000 acres in the Northerly Area. Implementation of Level 1 deep percolation reduction.

The acres retired are in addition to the 44,100 acres identified in Table 2-2. Results of the evaluation of these scenarios are summarized in Table 3-6. This table shows the assumptions and estimates as of a screening workshop held on April 7, 2004, with the exception that land retirement costs are corrected for the original and revised In-Valley Disposal Alternative. Some additional groundwater modeling analysis was performed to see if the need for drainage could be eliminated by combinations of deep percolation reduction and land retirement (less than complete retirement of all lands in the drainage-impaired area). Only a few combinations were tested, but were sufficient to determine that eliminating all need for current or future drainage service in Westlands could only be assured by retiring all drainage-impaired lands.

Broadview Water District lands were retired in all the In-Valley Land Retirement Alternatives, due to the pending transfer of their CVP water allocations to Pajero Valley Water Management Agency. Retirement of Northerly San Luis Unit lands other than Broadview was not included in this screening, because the initial screening showed land retirement to be more costly than drainage service. Since the Northerly Unit leads already have drainage system components in place (drains, collector system, recirculation systems, etc.), it was assumed that including these lands would be even less cost effective. Also, retirement of other Northerly Unit lands was eliminated from further analysis because uncontrolled drainage flows would continue to occur. These unmanaged flows include uncontrolled seepage into deep open drains, tailwater (from continued non-Unit farms) that is not able to be recycled, and runon from storm events. In the absence of drainage service, these uncontrolled flows would continue downstream and could reach the adjacent wildlife refuges on the San Joaquin River, resulting in adverse effects to water quality and wildlife. With no single entity responsible for managing these uncontrolled flows, the practical result would be ongoing environmental degradation for an indefinite period of time.

Table 3-6
Summary Results for Second Screening of Land Retirement Scenarios

	Original In-Valley	Revised In-Valley	Retire Lands with Se>50 ppb	Retire Lands with Se>20 ppb	Retire 198,000 acres in Westlands
Westlands Lands Retired	55,311	55,311	88,576	129,051	198,000
Northerly Area Lands Retired	Only lands necessary for facilities	Only lands necessary for facilities	Broadview (~10,000 acres) + lands necessary for facilities	Broadview (~10,000 acres) + lands necessary for facilities	Broadview (~10,000 acres) + lands necessary for facilities
Retired Lands Implementation Method	Mandatory, voluntary for CVPIA lands	Mandatory, voluntary for CVPIA lands	Mandatory	Mandatory	Mandatory
Source Control	In-Valley Plan	In-Valley Plan plus Deep Percolation Reduction	In-Valley Plan plus Deep Percolation Reduction	In-Valley Plan plus Deep Percolation Reduction	In-Valley Plan plus Deep Percolation Reduction
Groundwater Pumping	Safe Yield	Safe Yield	Safe Yield	Safe Yield	Safe Yield
Deep Percolation Reduction	Same as current	Reduce average to 0.27 foot in Westlands drainage-impaired area, and reduce by 0.10 foot in other areas	Reduce average to 0.27 foot in Westlands drainage-impaired area, and reduce by 0.10 foot in other areas	Reduce average to 0.27 foot in Westlands drainage-impaired area, and reduce by 0.10 foot in other areas	Reduce average to 0.27 foot in Westlands drainage-impaired area, and reduce by 0.10 foot in other areas
Cost (million $/year)	$46.29	$43.98	$44.42	$46.79	$51.29
Treatment/Disposal	$44.06	$35.78	$30.65	$25.76	$17.86
Land Retirement	$2.23	$2.23	$8.85	$16.90	$30.62
Deep Percolation Reduction	$0.00	$5.97	$4.92	$4.13	$2.80
Westlands Acres Drained (2050)	169,514	111,938	96,052	76,724	43,800
Westlands Drainflow from Fields in 2050 (AF/year)	54,358	42,447	36,625	32,308	25,451
Net change in Westlands Water Applied (relative to original In-Valley)	-	43,805	121,987	217,115	379,164

Note: These estimates were prepared for the screening workshop on April 7, 2004. Estimates of quantities and costs have been refined since that time.

3.3.10.3 Additional Analysis

Subsequent to the second screening, the Technical Team further discussed and analyzed deep percolation rates in the Westlands drainage-impaired area. Team members concluded that:

- Existing deep percolation rates averaging 0.32 foot/year already reflect application efficiencies of greater than 85 percent.
- Additional reduction of deep percolation to 0.27 foot/year would be extremely difficult to achieve and would be just as difficult to verify. Efficiencies that high require both expensive irrigation hardware, such as subsurface drip systems or low-energy precision application (LEPA) systems, and very careful water management by growers.
- Growers installing drainage systems would want to move water and salts out of the root zone and into drains, to reclaim soil and shallow groundwater that have been accumulating salts for many years. Lower deep percolation rates would prevent them from getting the full benefit of better drainage. Further, the higher soil salinity implied by the lower deep percolation rates and leaching could restrict growers from planting salt-sensitive crops.
- Deep percolation reduction still makes sense and appears very cost-effective in areas of the San Luis Unit with higher existing deep percolation rates, including upslope areas of Westlands and the Northerly Area.
- More detailed analysis of field-level drainage operations indicated a rate of about 0.35 foot/year from new Westlands drained lands would be an appropriate estimate for purposes of planning facilities and operations.

Team members agreed to modify the Level 1 deep percolation reduction, implementing no new deep percolation reduction on the Westlands drainage-impaired lands, but reducing target rates by 0.1 foot/year in the other areas (no change from the original Level 1 targets).

The groundwater modeling analysis indicated drainage rates of about 0.19 AF/drained acre/year, based on the original Level 1 deep percolation reduction (see Appendix A). The Technical Team was concerned that the low drainage rates projected by the model might lead to underestimating the costs of treatment and disposal facilities. Team members discussed whether the estimate from the groundwater model was the most appropriate for purposes of assessing costs and impacts of drainage service, and drew the following conclusions:

- Raising the assumed deep percolation rate from 0.27 up to 0.32 foot/year in the drainage-impaired area (see discussion above) would likely increase the rate of drainflow by about 0.05 foot/year compared to the groundwater model estimates.
- The groundwater model is designed to estimate long-term trends in groundwater conditions, therefore, is based on an annual time step. Drainflow fluctuates substantially over a period of days immediately following irrigation applications. As a consequence, the groundwater model may underestimate peak drainflows following irrigations. The Technical Team believes that the detailed, daily time-step analysis is likely to provide more accurate projections of drainflow.

Based on these considerations, drainflow from new drained lands in Westlands was assumed to be 0.35 foot/acre. This value was confirmed with the Project Team and used for estimating costs of treatment and disposal facilities.

A revision of the 198,000-acre retirement scenario was analyzed subsequent to the second screening workshop. The revised scenario retired land in Westlands up to the level at which all water made available from retired land could be used to meet other irrigation demands within the Unit. This retirement level was determined to be 185,880 acres.

3.3.11 Benefits and Costs from a National Perspective

The same set of scenarios was evaluated using a methodology for estimating costs and benefits that is defined in the *Principles and Guidelines*. The methodology can be used to identify an alternative that has the greatest net benefit (benefits minus costs) to the United States as a whole. This alternative is referred to as the NED alternative. The *Principles and Guidelines* set out procedures for estimating the true economic costs and benefits of an alternative (some of these procedures were described earlier in Section 3.3.7, Value of Agricultural Production Lost to Retirement). This analysis is an initial application of the *Principles and Guidelines* methodology to the land retirement scenarios for the purposes of formulating and screening land retirement alternatives. Estimates of costs and benefits are ongoing and a full NED analysis of alternatives will be performed as part of the Re-evaluation study.

3.3.11.1 Approach

Most of the costs estimated for land retirement scenarios apply in the NED analysis, with a couple of qualifications. The first is the way a NED analysis handles land retirement. The *Principles and Guidelines* does not specifically address how to assess the costs of a large-scale retirement of existing agricultural land. Valuing agricultural land is addressed in two places and in two ways in the *Principles and Guidelines*. For purchasing relatively small amounts of land as needed for new project facilities, the *Principles and Guidelines* recommends using market prices (Section 2.12.5(h)), though it recognizes the need for a surrogate approach when market price is not available or inappropriate (Section 2.12.2(c)). For bringing large amounts of land into production, the *Principles and Guidelines* (Section 2.3) does not rely on a market price approach to value that land, but rather uses a net income approach to estimate the value to the national economy of the change in agricultural production.

A net income approach can be the preferred method of estimating the cost of purchasing land for retirement for two reasons. First, the purchase program may have unique conditions or be of such a scale that past negotiated sales prices may not apply. For example, land appraisers rely on the net income approach to estimate the true market value of land when comparable sales are not available or for some reason are not representative. Second, a divergence may exist between the market transaction price for the land and the true economic cost from a national perspective. This scenario can occur, for example, when market prices are strongly influenced by farm commodity payments or other subsidy programs. The market price would incorporate the value of the subsidy, when in fact the subsidy is simply a transfer payment and not a true cost or benefit from a national perspective. The *Principles and Guidelines* directs that the true cost or benefit be estimated by eliminating the value of the subsidy and instead using net income estimates based on subsidy-free prices.

It would not be appropriate to count both the cost of purchasing land and the value of lost net income as NED costs. As described above, they are two different ways of estimating the same thing, namely the cost to the national economy of removing land from production. An analogous example occurs when Reclamation is purchasing land containing a business (say, a gasoline service station) to make way for a new reservoir. The cost of purchasing the land and business is appropriately shown as a project cost. It would double-count costs to estimate the future stream of profits from that business and add that as another, separate project cost. The value of that future profit is already embodied in the market price paid for the business.

Using the net income lost as an estimate of NED cost of land retirement in the San Luis Unit actually yields a value very similar to the assumed purchase cost. In Westlands the present value of discounted net income from agricultural production (using the methods in the *Principles and Guidelines* as described above) is estimated to be $2,456 per acre, compared to $2,600 per acre assumed as the purchase price. Therefore, results of the NED analysis would be essentially the same regardless of which estimate of land retirement cost is used. Again note that only one of the two values is counted as a project cost. From a national perspective, the payment received by growers to retire land is called a transfer payment – the loss to one group (the Federal treasury) is exactly matched by the gain to another group (growers receiving payment). The true cost of retirement to the national economy is the value of goods and services lost (in this case, the loss of a stream of annual net returns to agricultural production). Other costs to manage the lands and to administer the program are true economic costs and are included as such in the NED analysis.

The second major difference between the NED analysis and the cost comparisons presented in the previous section is that the value of resources (in this case, water) made available for other uses is accounted for explicitly as an economic benefit. The value of the water is estimated as the avoided cost of obtaining the water from another source, using the approach described earlier in this chapter.

3.3.11.2 Results

Table 3-7 summarizes the comparison of NED economic costs and benefits. An important benefit of all drainage service alternatives is that they avoid the cost of salinity impacts that would continue to grow over time in absence of drainage service. These avoided costs were not estimated for the land retirement screening analysis, but are expected to be roughly comparable across the scenarios. In other words, all scenarios provide adequate drainage service either through providing drainage or by avoiding the need for drainage.

The most striking conclusion apparent in Table 3-7 is the effect of counting the benefit of water available for other uses. The cost estimates shown in Table 3-6 include the cost of purchasing land, but a major part of the cost of purchasing irrigated land is the value of its associated water. A difficulty in comparing scenarios on the basis of cost alone (as in Table 3-6) is that no offsetting benefit, namely the value of the water, is shown. The NED analysis does include that offsetting benefit, estimated as the avoided cost of purchasing other water supplies. As a result, the NED comparison of scenarios favors retiring larger amounts of land, at least within the range considered in this screening.

Estimates in Table 3-7 compare only the In-Valley Disposal Alternative and the In-Valley/Land Retirement Alternatives. The net cost ranking among those alternatives would not change if costs and benefits were measured relative to a No Action Alternative.

3.3.11.3 Discussion

Results in Table 3-7 indicate that land retirement can reduce the net cost of drainage service. It does not follow from this analysis that retiring ever more land (even going outside the drainage-impaired area) would always be better from an NED perspective. For simplicity, we have assumed here a constant unit value of $90/AF, and this is a reasonable estimate of the value of water reallocated for agricultural use within the San Luis Unit. If water became available beyond internal Unit uses, the demand would shift to other uses such as Level 4 refuge supply, the Environmental Water Account, and sales to other CVP and non-CVP service areas (including urban areas). These other demands are not unlimited, and the per-AF willingness to pay for water from retired lands would begin to decline as more came onto the market.

An alternative way of assessing the benefit of land retirement is to assume that San Luis Unit districts would not be able or willing to provide irrigation water to serve all existing lands. One could argue that, in the absence of land retirement, the Unit districts would choose not to acquire supplemental water supplies to meet their water demand. In this case no avoided cost of other water supplies would occur, and the benefits line in Table 3-7 would have only zeroes. Using this assumption, clearly not all lands in the Unit could remain in production (given the assumption that long-term average groundwater use is equal to safe yield). A new benefit (avoided cost) row would need to be added in Table 3-7 showing the avoided cost (the lost value of production) of involuntary fallowing elsewhere in the Unit. This benefit would increase as land retirement provided additional water to keep the involuntarily fallowed land in production. If the involuntarily fallowed lands were similar in water use and crop net income to those retired as part of drainage service, then the benefit would equal the cost of retirement, up to the point where all remaining lands had sufficient water supply. In other words, a formal land retirement program would not actually change the amount of land in production, it would simply replace involuntary fallowing with a targeted retirement program. The resulting net cost by alternative would show a similar pattern to that currently shown in Table 3-7.

Table 3-7
Comparison of Costs and Benefits from a National Perspective

	Original In-Valley	**Revised In-Valley**	**Retire Lands with Se>50 ppb**	**Retire Lands with Se>20 ppb**	**Retire 198,000 acres in Westlands**
Costs					
Treatment and Disposal Cost (Million $/year)	$44.06	$35.78	$30.65	$25.76	$17.86
Loss of Ag Production on Retired Lands (Million $/year)	$0.00	$0.00	$4.92	$10.91	$21.12
Admin/Mgmt Costs of Land Retirement (Million $/year)	$0.00	$0.00	$1.42	$3.14	$6.08
Cost of Deep Percolation Reduction (Million $/year)	$0.00	$5.97	$4.92	$4.13	$2.80
Benefits					
Avoided Cost of Other Water Supplies in San Luis Unit (Million $/year)	$0.00	$4.38	$12.20	$21.71	$31.39
Other Benefits of Salinity Improvements	Not estimated for land retirement screening analysis				
Net Cost of Scenario (Million $/year)					
	$44.06	$37.37	$29.71	$22.23	$16.47

Note: Analysis of benefits and costs is ongoing. These estimates were prepared for the screening workshop on April 7, 2004. Estimates of quantities and costs have been refined since that time.

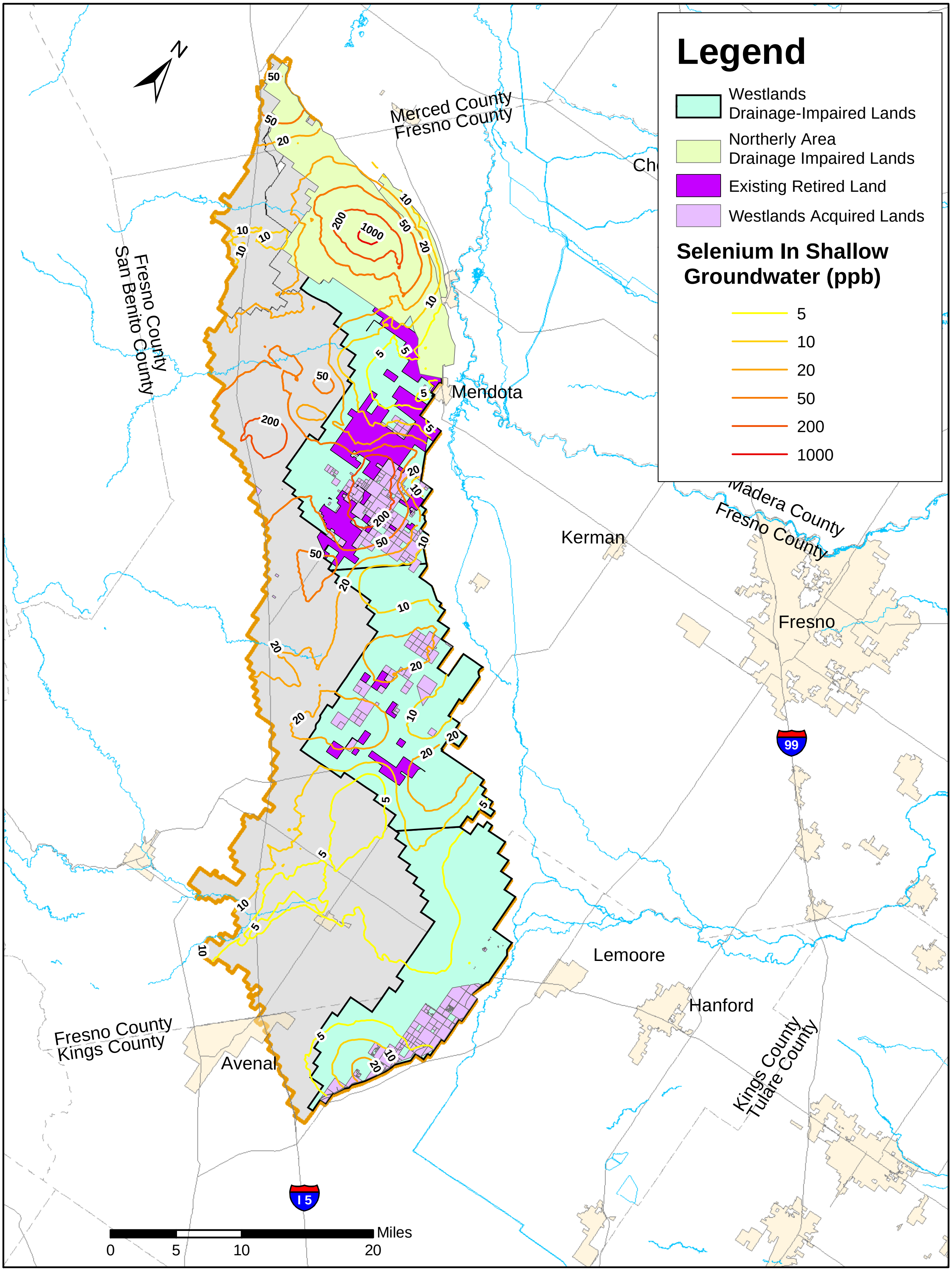
3.4 SELECTED LAND RETIREMENT SCENARIOS

Based on the screening of the many combinations of land retirement and other drainwater reduction measures, three land retirement scenarios were selected to become alternatives for analysis in the EIS. All three are assumed to be variations of the original In-Valley Disposal Alternative (Alternative 4) in the 2002 PFR, which assumed 44,106 acres existing and planned land retirement in Westlands (Sumner-Peck, Britz, CVPIA). See Table 2-2 for a listing of retired lands for all of the alternatives and Sections 5.6 through 5.8 for more detailed descriptions. All three land retirement alternatives assume implementation of additional retired land as mandatory in the sense that identified lands would not be provided drainage service. The land retirement alternatives are:

- The **In-Valley/Groundwater Quality Alternative** would retire land with Se concentration greater than 50 ppb in shallow groundwater. This alternative corresponds closely to one of the scenarios evaluated in the land retirement screening. A total of 92,592 acres would be retired, including the 44,106 identified in the In-Valley Disposal Alternative, an additional 38,486 acres in Westlands, and 10,000 acres in the Northerly Area in Broadview Water District.
- The **In-Valley/Water Needs Alternative** retires 193,956 acres. It would retire land in Westlands up to the level at which the water made available could be used to fulfill other irrigation demands in the San Luis Unit. This was described in Section 3.3.11, and includes the 44,106 identified in the In-Valley Disposal Alternative, an additional 139,850 acres in Westlands, and 10,000 acres in the Northerly Area in Broadview Water District.
- The **In-Valley/Drainage-Impaired Area Alternative** would retire 308,000 acres. It contains the entire drainage-impaired area in Westlands, including the 44,106 identified in the In-Valley Disposal Alternative, plus an additional 253,894 acres. 10,000 acres would be retired in the Northerly Area in Broadview Water District.

Figure 3-2 shows the drainage-impaired areas, existing retired lands, land acquired by Westlands, and Se groundwater concentrations. Section 3.3 of this addendum explained how these characteristics were used to develop land retirement alternatives.

Under the Sagouspe settlement (65,000 acres), Westlands has acquired approximately 38,000 acres, and these are shown on the map. Under No Action another 27,000 acres would be acquired in the future and these are not displayed on Figure 3-2. Of the 38,000 acres acquired by Westlands, on average 10 percent of the land is irrigated with groundwater or water from other (non-Westlands) sources.



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San Luis Drainage Feature Re-evaluation	Characteristics for Land Retirement Analysis	Figure 3-2
17324004		

3.5 REVISED COSTS FOR IN-VALLEY ALTERNATIVES

Costs for the In-Valley Disposal Alternative (with Level 1 irrigation efficiency) are provided in Table 3-8, and total annual equivalent costs vary from $60.7 million (mandatory or “block” retirement) to $61.3 million (voluntary or “checkerboard” pattern of retirement) costs for the three land retirement alternatives are provided in Tables 3-9, 3-10, and 3-11.

The three land retirement alternatives are more costly than the In-Valley Disposal Alternative:

- In-Valley/Groundwater Quality $61.5 to $63.1 million
- In-Valley/Water Needs $65.5 to $70.5 million
- In-Valley/Drainage-Impaired Area $69.5 to $79.9 million

Table 3-8
San Luis Drainage Cost Curve Estimates for the In-Valley Disposal Alternative

Project Feature	Unit of Estimate	Units Estimated for Alternative	Estimated Capital Cost	Rounded Capital Cost	Estimated OM&R Cost	Rounded OM&R Cost	Total Annual
Irrigation Efficiency Improvement	Acres	379,000			2,625,080	2,625,000	
Source Reduction							
Drainwater Recycling	Acres	246,030	41,087,010	41,087,000	590,472	590,000	
Shallow Groundwater Management	Acres	40,355	-	-	758,674	759,000	
Seepage Reduction	Acres	36,000	10,689,000	10,689,000	(18,600)	(19,000)	
On-Farm Drains[1]	Acres	165,020	109,738,300	109,738,000	2,049,388	2,049,000	
Reuse[1]	Acres	14,697	65,401,650	65,402,000	3,800,000	3,800,000	
Collection System							
Block – mandatory[1]	Acres	252,030	186,772,500	186,773,000	3,924,360	3,924,000	
Checkerboard – voluntary[1]	Acres	252,030	197,269,372	197,269,000	3,924,360	3,924,000	
Conveyance System (In-Valley)	cfs	29	41,933,801	41,934,000	377,701	378,000	
Reverse Osmosis	cfs	21,016	22,180,756	22,181,000	3,464,176	3,464,000	
Selenium Treatment	cfs	15	60,588,654	60,589,000	1,965,558	1,966,000	
Evaporation Basins[2,3]	cfs	3,290	43,715,947	43,716,000	360,675	361,000	
Evaporation Basin Mitigation[3]	cfs	3,590	39,502,842	39,503,000	359,000	359,000	
Land Retirement	Acres	13,151	39,716,020	39,716,000	677,407	677,000	
Total Alternative Cost - Block			661,326,480	661,328,000	20,933,891	20,933,000	60,711,000
Annual Equivalent			39,777,740	39,778,000			
Total Alternative Cost - Voluntary			671,823,352	671,824,000	20,933,891	20,933,000	61,342,000
Annual Equivalent			40,409,110	46,409,000			

[1]Capital costs are based on acres of new features constructed for the alternative. OM&R costs are based on new features plus existing features.

[2]Capital costs are based on acres of evaporation basins required to accommodate peak flows. OM&R costs are based on acres of evaporation basins estimated for annual average flows.

[3]Capital costs include land acquisition costs of $2,600/acre.

Table 3-9
San Luis Drainage Cost Curve Estimates for the In-Valley/Groundwater Quality Land Retirement Alternative

Project Feature	Unit of Estimate	Units Estimated for Alternative	Estimated Capital Cost	Rounded Capital Cost	Estimated OM&R Cost	Rounded OM&R Cost	Total Annual
Irrigation Efficiency Improvement	Acres	379,000			2,625,050	2,625,000	
Source Reduction							
Drainwater Recycling	Acres	209,424	34,973,808	34,974,000	502,618	503,000	
Shallow Groundwater Management	Acres	34,254	-	-	643,975	644,000	
Seepage Reduction	Acres	36,000	10,689,000	10,689,000	(18,600)	(19,000)	
On-Farm Drains[1]	Acres	140,616	93,509,640	93,510,000	1,758,890	1,759,000	
Reuse[1]	Acres	12,397	55,166,650	55,167,000	3,340,000	3,340,000	
Collection System							
Block – mandatory[1]	Acres	215,424	159,318,000	159,318,000	3,365,088	3,365,000	
Checkerboard – voluntary[1]	Acres	215,424	186,270,440	186,270,000	3,365,088	3,365,000	
Conveyance System (In-Valley)	cfs	25	39,185,519	39,186,000	326,809	327,000	
Reverse Osmosis	cfs	18,458	21,016,321	21,016,000	3,449,600	3,450,000	
Selenium Treatment	cfs	13	53,889,626	53,890,000	1,743,541	1,744,000	
Evaporation Basins[2,3]	cfs	2,890	39,668,637	39,669,000	317,461	317,000	
Evaporation Basin Mitigation[3]	cfs	3,160	36,764,346	36,764,000	316,000	316,000	
Land Retirement	Acres	48,937	147,789,740	147,790,000	1,513,791	1,514,000	
Total Alternative Cost - Block			691,971,286	691,973,000	19,884,254	19,885,000	61,506,000
Annual Equivalent			41,620,976	41,621,000			
Total Alternative Cost - Voluntary			718,923,727	718,925,000	19,884,254	19,885,000	63,127,000
Annual Equivalent			43,242,123	43,242,000			

[1]Capital costs are based on acres of new features constructed for the alternative. OM&R costs are based on new features plus existing features.

[2]Capital costs are based on acres of evaporation ponds required to accommodate peak flows. OM&R costs are based on acres of evaporation ponds estimated for annual average flows.

[3]Capital costs include land acquisition costs of $2,600/acre.

Table 3-10
San Luis Drainage Cost Curve Estimates for the In-Valley/Water Needs Land Retirement Alternative

Project Feature	Unit of Estimate	Units Estimated for Alternative	Estimated Capital Cost	Rounded Capital Cost	Estimated OM&R Cost	Rounded OM&R Cost	Total Annual
Irrigation Efficiency Improvement	Acres	379,000			2,625,080	2,625,000	
Source Reduction							
Drainwater Recycling	Acres	113,000	18,871,000	18,871,000	271,200	271,000	
Shallow Groundwater Management	Acres	18,183	-	-	341,847	342,000	
Seepage Reduction	Acres	36,000	10,689,000	10,689,000	(18,600)	(19,000)	
On-Farm Drains[1]	Acres	76,333	50,761,667	50,762,000	1,154,633	1,155,000	
Reuse[1]	Acres	8,197	36,476,650	36,477,000	2,500,000	2,500,000	
Collection System							
Block – mandatory[1]	Acres	119,000	87,000,000	87,000,000	2,208,000	2,208,000	
Checkerboard – voluntary[1]	Acres	119,000	170,125,399	170,125,000	2,208,000	2,208,000	
Conveyance System (In-Valley)	cfs	19	33,324,441	33,324,000	238,190	238,000	
Reverse Osmosis	cfs	13,730	18,201,712	18,202,000	3,129,784	3,130,000	
Selenium Treatment	cfs	9	41,344,700	41,345,000	1,329,608	1,330,000	
Evaporation Basins[2,3]	cfs	2,150	31,600,806	31,601,000	235,426	235,000	
Evaporation Basin Mitigation[3]	cfs	2,350	30,698,811	30,699,000	235,000	235,000	
Land Retirement	Acres	145,361	438,990,220	438,990,000	3,262,320	3,262,000	
Total Alternative Cost – Block			797,959,003	797,960,000	17,512,488	17,512,000	65,508,000
Annual Equivalent			47,995,969	47,996,000			
Total Alternative Cost - Voluntary			881,084,402	881,085,000	17,512,488	17,512,000	70,508,000
Annual Equivalent			52,995,830	52,996,000			

[1]Capital costs are based on acres of new features constructed for the alternative. OM&R costs are based on new features plus existing features.

[2]Capital costs are based on acres of evaporation ponds required to accommodate peak flows. OM&R costs are based on acres of evaporation ponds estimated for annual average flows.

[3]Capital costs include land acquisition costs of $2,600/acre.

Table 3-11
San Luis Drainage Cost Curve Estimates for the Drainage-Impaired Area Land Retirement Alternative

Project Feature	Unit of Estimate	Units Estimated for Alternative	Estimated Capital Cost	Rounded Capital Cost	Estimated OM&R Cost	Rounded OM&R Cost	Total Annual
Irrigation Efficiency Improvement	Acres	379,000			2,625,080	2,625,000	
Source Reduction							
Drainwater Recycling	Acres	-	-	-	-	-	
Shallow Groundwater Management	Acres	600	-	-	11,280	11,000	
Seepage Reduction	Acres	36,000	10,689,000	10,689,000	(18,600)	(19,000)	
On-Farm Drains[1]	Acres	6,000	3,990,000	3,990,000	446,500	447,000	
Reuse[1]	Acres	3,197	14,226,650	14,227,000	1,500,000	1,500,000	
Collection System							
Block – mandatory[1]	Acres	6,000	2,250,000	2,250,000	852,000	852,000	
Checkerboard – voluntary[1]	Acres	6,000	174,869,817	174,870,000	852,000	852,000	
Conveyance System (In-Valley)	cfs	11	25,027,859	25,028,000	141,967	142,000	
Reverse Osmosis	cfs	8,100	13,731,399	13,731,000	2,253,398	2,253,000	
Selenium Treatment	cfs	6	26,142,477	26,142,000	831,047	831,000	
Evaporation Basins[2,3]	cfs	1,270	21,025,948	21,026,000	139,230	139,000	
Evaporation Basin Mitigation[3]	cfs	1,390	21,975,656	21,976,000	139,000	139,000	
Land Retirement	Acres	258,361	780,250,220	780,250,000	5,312,999	5,313,000	
Total Alternative Cost - Block			919,309,206	919,309,000	14,233,903	14,233,000	69,528,000
Annual Equivalent			55,294,992	55,295,000			
Total Alternative Cost - Voluntary			1,091,929,022	1,091,929,000	14,233,903	14,233,000	79,911,000
Annual Equivalent			65,677,800	65,678,000			

[1]Capital costs are based on acres of new features constructed for the alternative. OM&R costs are based on new features plus existing features.

[2]Capital costs are based on acres of evaporation ponds required to accommodate peak flows. OM&R costs are based on acres of evaporation ponds estimated for annual average flows.

[3]Capital costs include land acquisition costs of $2,600/acre.